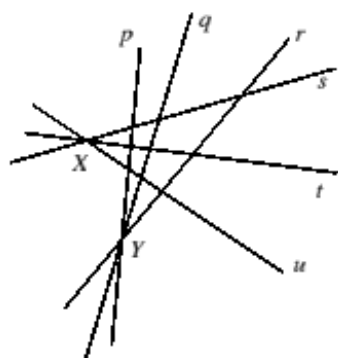25.

Challengeborough's underground train network consists of six lines, p, q, r, s, t, u, as shown. Wherever two lines meet there is a station which enables passengers to change lines. On each line, each train stops at every station.

Jessica wants to travel from station X to station Y. She does not want to use any line more than once, nor return to station X after leaving it, nor leave station Y having reached it.

How many different routes, satisfying these conditions, can she choose?

A 9　　　　B 36　　　C 41　　　D 81　　　E 720

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25. D Jessica must travel alternately on lines which are connected to station X (i.e. s, t or u), and connected to station Y (i.e. p, q or r). In order to depart from X and end her journey at Y, she must travel along an even number of lines. This can be 2, 4 or 6 lines, making 1, 3 or 5 changes respectively.

Case A, 2 lines: Jessica leaves station X along one of the lines s, t or u, makes one change onto one of lines p, q or r and reaches station Y. Here there are 3×3 possibilities.

Case B, 4 lines: Jessica leaves station X along one of the lines s, t or u and makes her first change onto one of lines p, q or r. She then makes her second change onto either of the two lines s, t or u on which she has not previously travelled and her third change onto either of the two lines p, q or r on which she has not previously travelled and reaches station Y. Here there are $3 \times 3 \times 2 \times 2$ possibilities.

Case C, 6 lines: Her journey is as described in Case B but her fourth change is onto the last of the lines s, t or u on which she has not previously travelled and her fifth change is onto the last of the lines p, q or r on which she has not previously travelled. Here there are $3 \times 3 \times 2 \times 2 \times 1 \times 1$ possibilities.

So in total Jessica can choose $9 + 36 + 36 = 81$ different routes.